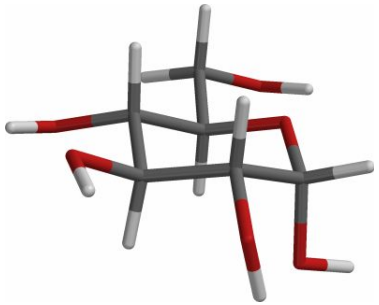

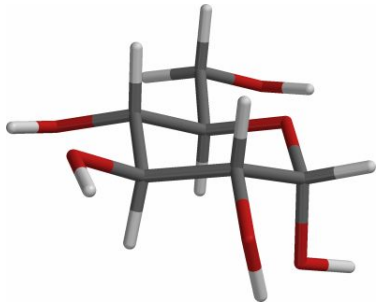

Chem 109 C

Fall 2014

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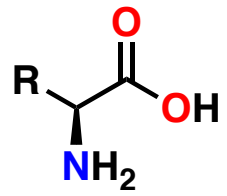
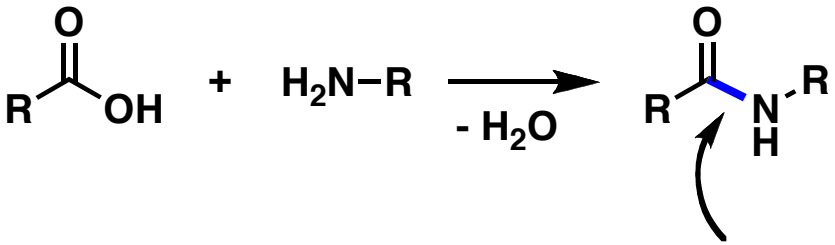
http://web.chem.ucsb.edu/~zakariangroup/courses.html

Amino acids, Peptides, Proteins: Introduction

Chapter 22



α-amino acid



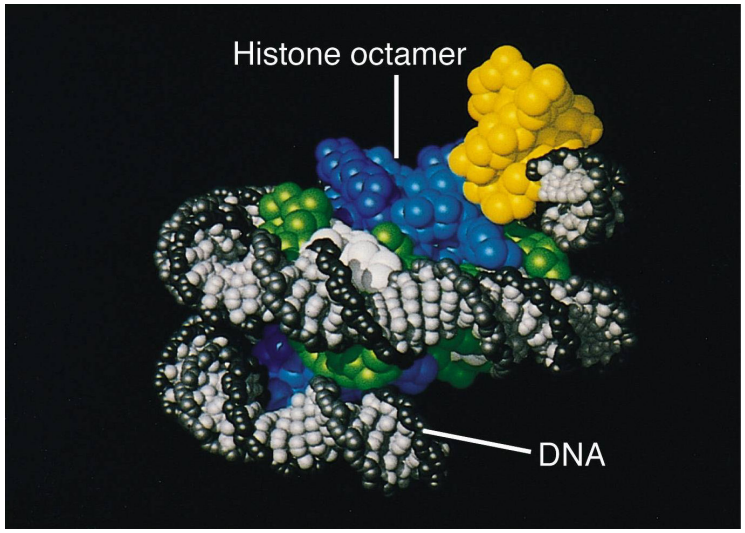
peptide bond = amide bond

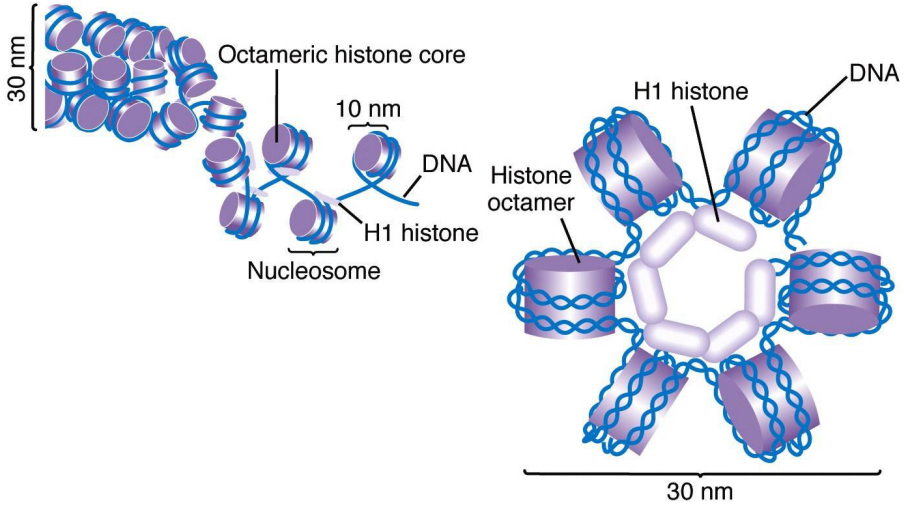
Proteins: Function

Table 22.1 Examples of the Many Functions of Proteins in Biological Systems

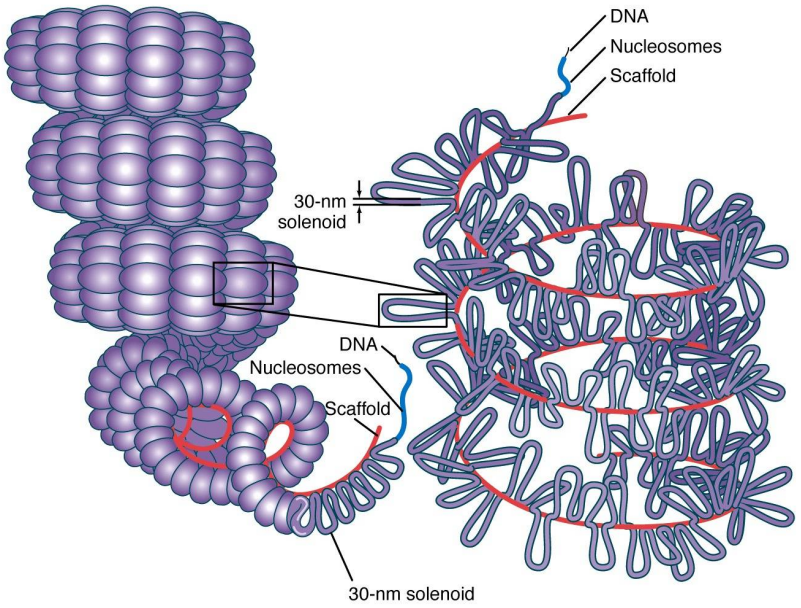
Structural proteins	These proteins impart strength to biological structures or protect organisms from their environment. For example, collagen is the major component of bones, muscles, and tendons; keratin is the major component of hair, hooves, feathers, fur, and the outer layer of skin.
Protective proteins	Snake venoms and plant toxins protect their owners from predators. Blood-clotting proteins protect the vascular system when it is injured. Antibodies and peptide antibiotics protect us from disease.
Enzymes	Enzymes are proteins that catalyze the reactions that occur in living systems.
Hormones	Some of the hormones, such as insulin, that regulate the reactions that occur in living systems are proteins.
Proteins with physiological functions	These proteins are responsible for physiological functions such as the transport and storage of oxygen in the body, the storage of oxygen in the muscles, and the contraction of muscles.

Proteins: Structural

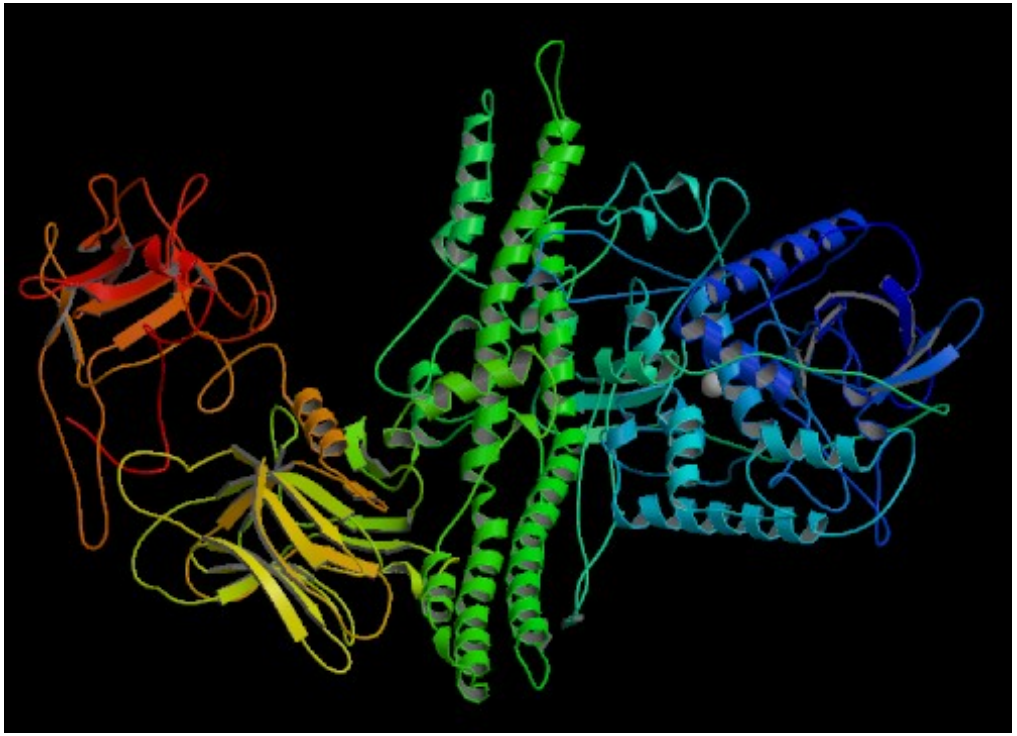




Histone Protein Structure: DNA packaging

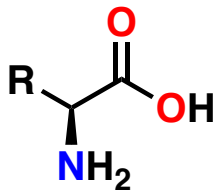


Proteins: Protective

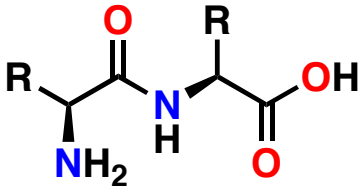


botulinum toxin (botox) structure
most toxic substance known

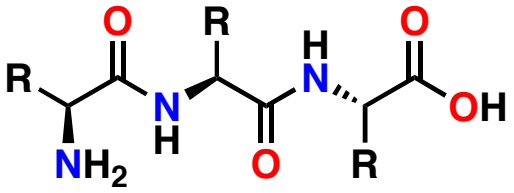
Amino acids, Peptides, Proteins: Introduction



α-amino acid



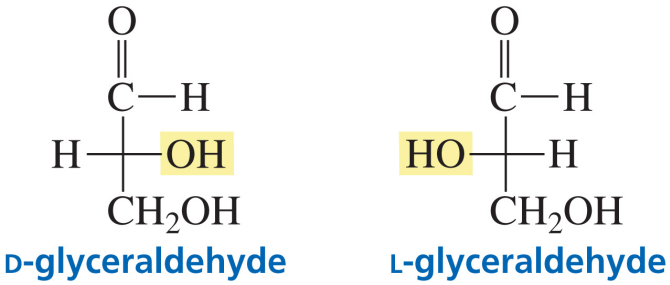
dipeptide

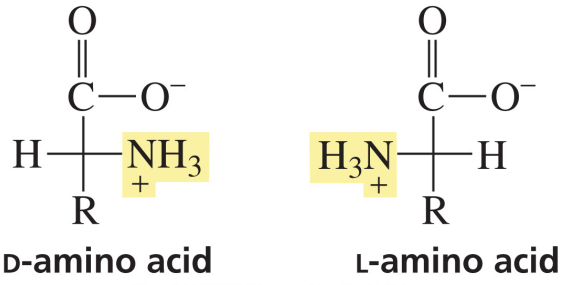


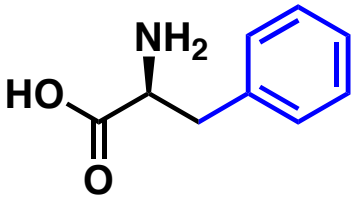
tripeptide

- ✓ **oligopeptide: 3 - 10 amino acids**
- ✓ **polypeptide, or protein: many amino acids**

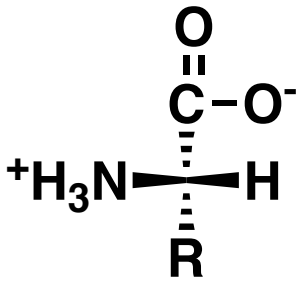
Proteins: Amino Acids, Configuration



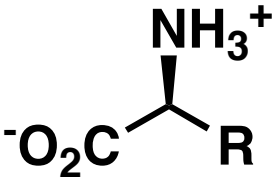




phenylalanine

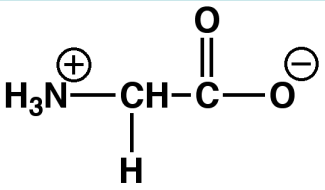


same as

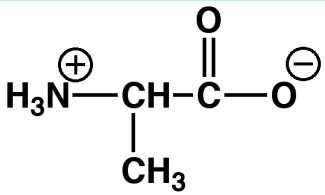


Classification of Amino Acids

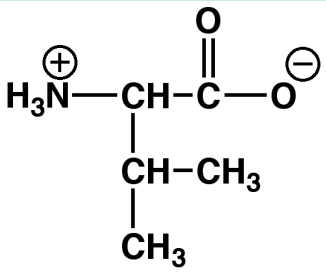
- **Hydrophobic: water-fearing, nonpolar side chains**
  - **Alkyl side chain**
- **Hydrophilic: water-loving side chains**
  - **Polar, neutral side chains**
  - **Anionic**
  - **Cationic**



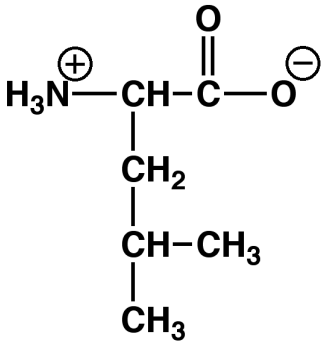
Glycine



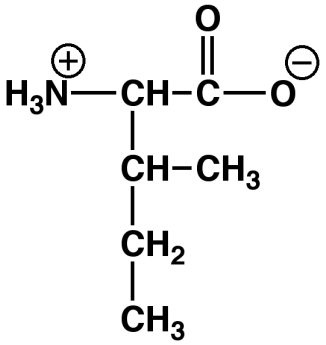
Alanine



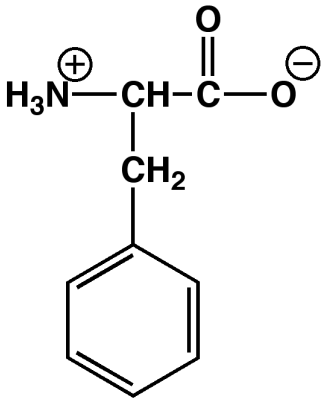
Valine



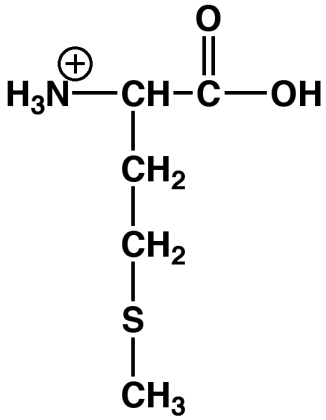
Leucine



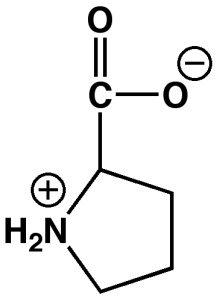
Isoleucine



Phenylalanine

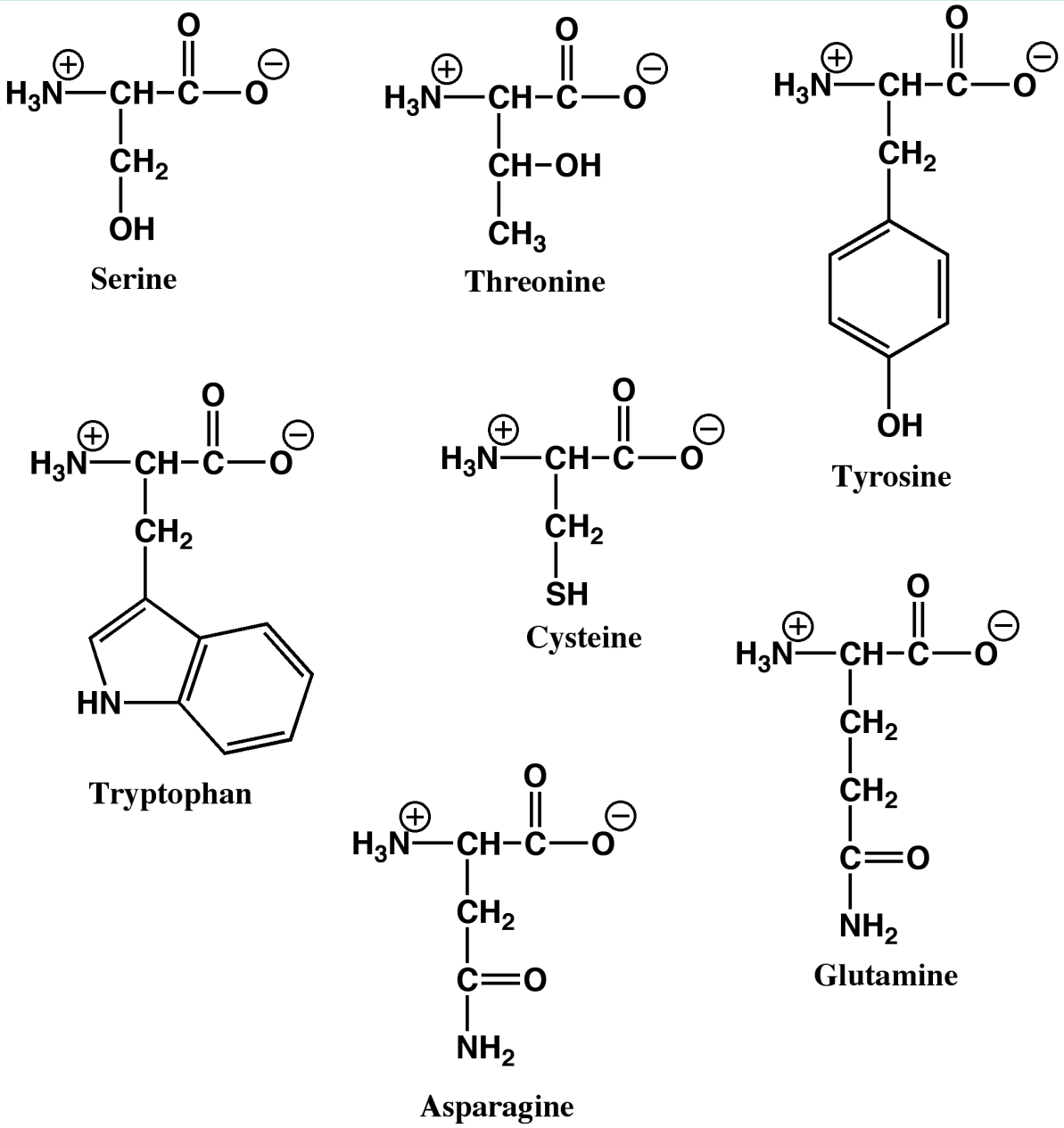


Methionine



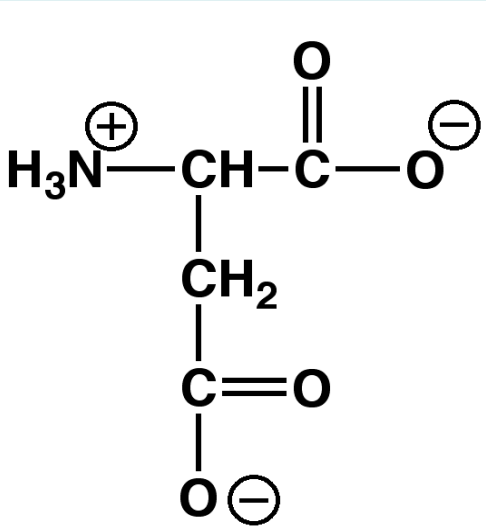
Proline

Nonpolar Side Chains

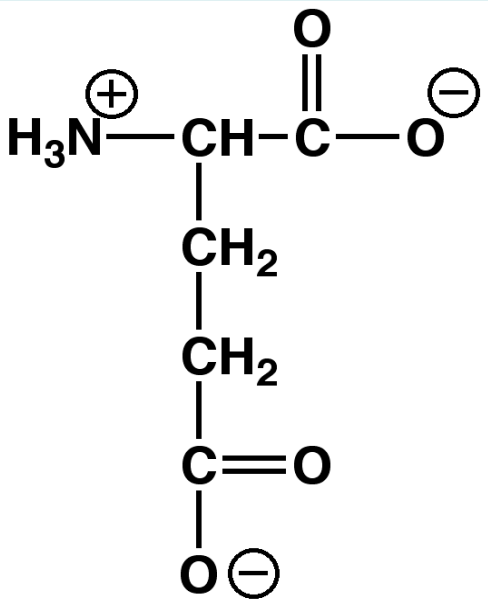


Polar, Neutral Side Chains

Polar, Acidic Side Chains

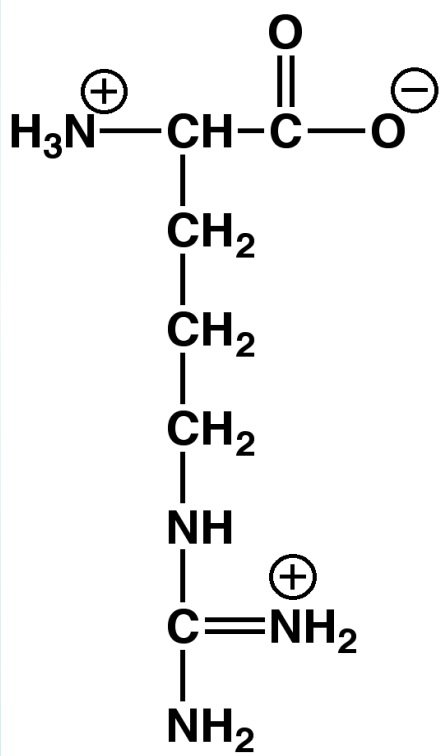


Asparatic Acid

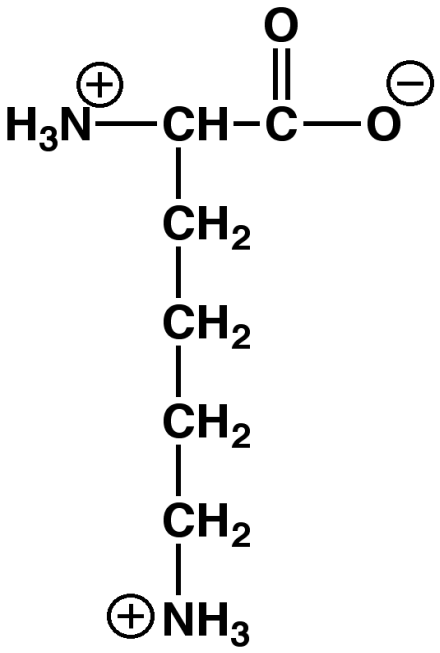


Glutamic Acid

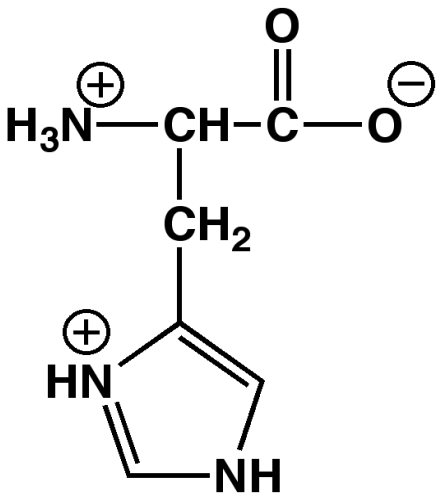
Basic, Polar Side Chains



Arginine



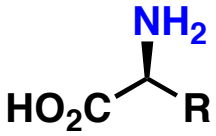
Lysine



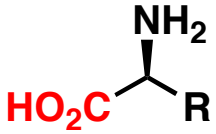
Histidine

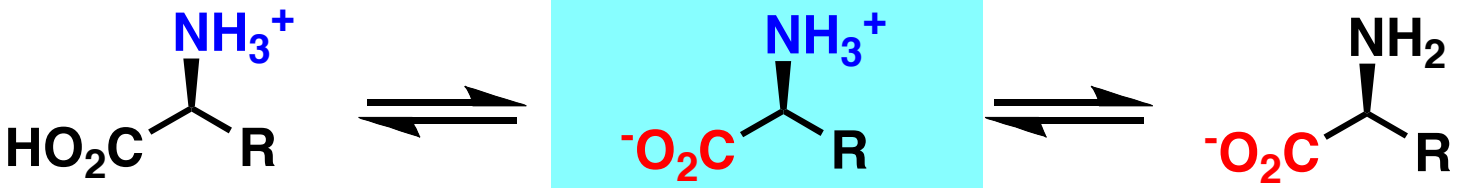
Amino acids: Zwitterions

✓ contain the amino group



✓ contain the carboxylic acid group:

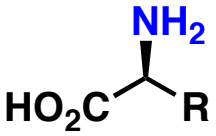




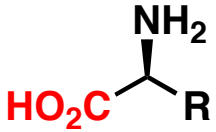
pH = 0 **pH = 7** **pH = 11**

Amino acids: Zwitterions

pKa of amino acids:



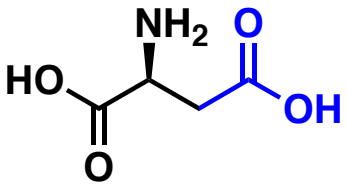
α-amino: 8.84 - 10.60



carboxylic acid: 1.82 - 2.63

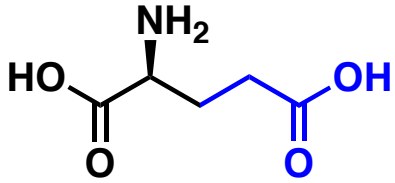
Amino acids: Zwitterions

pKa of side-chains:



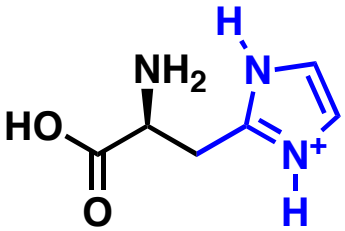
aspartic acid

pKa 3.86



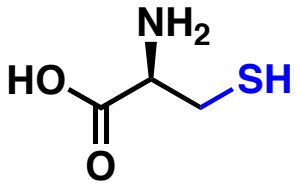
glutamic acid

pKa 4.25



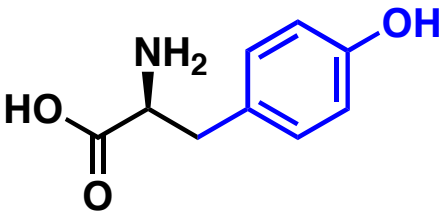
histidine

pKa 6.04



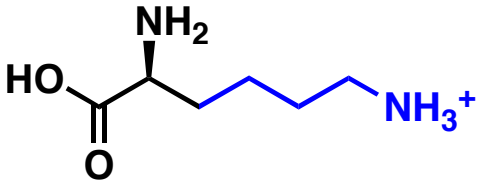
cysteine

pKa 8.35



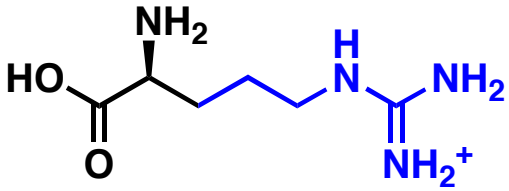
tyrosine

pKa 10.07



lysine

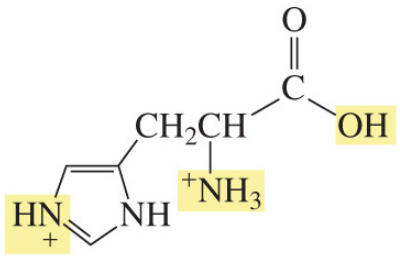
pKa 10.79



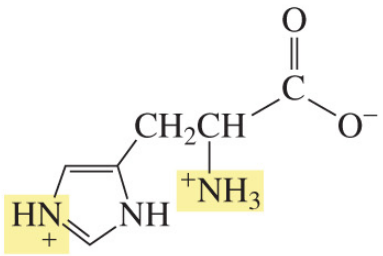
arginine

pKa 12.48

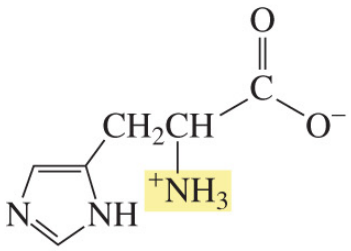
Amino acids: Zwitterions



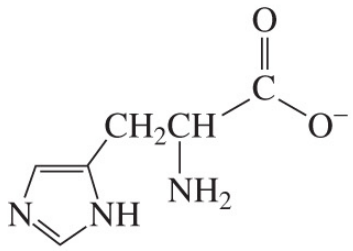
pH = 0



pH = 4



pH = 8



pH = 12

histidine

Amino acids: Zwitterions

PROBLEM 8

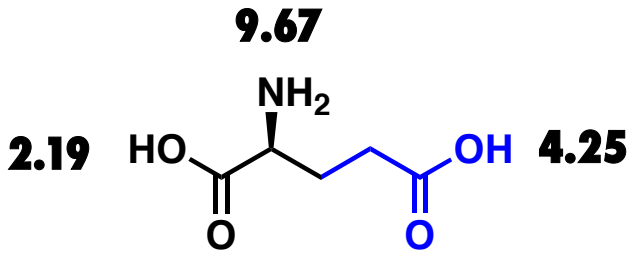
Draw the predominant form of glutamic acid in a solution with the following pH:

a. 0

b. 3

c. 6

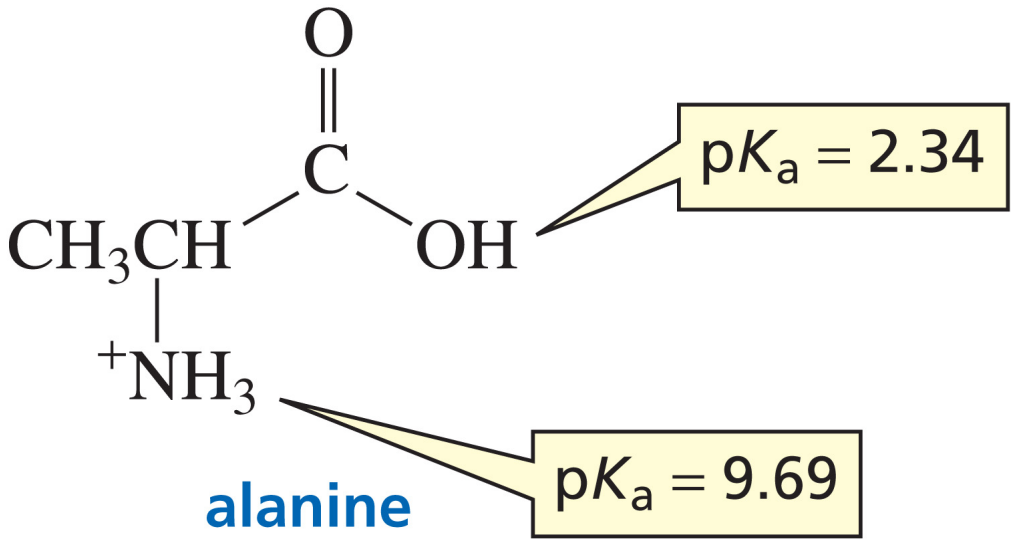
d. 11



glutamic acid

Amino acids: Isoelectric Point (pI)

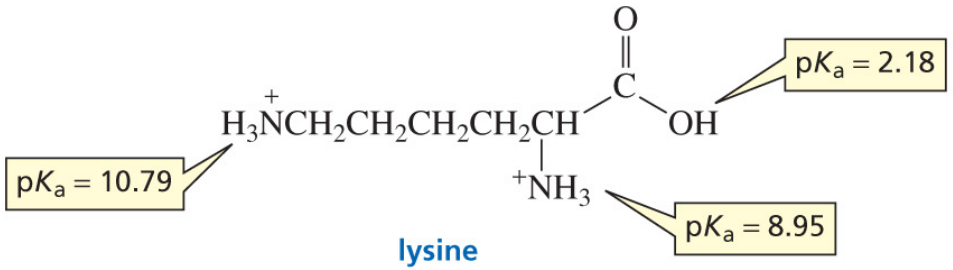
pI of amino acid is pH at which it has no net charge



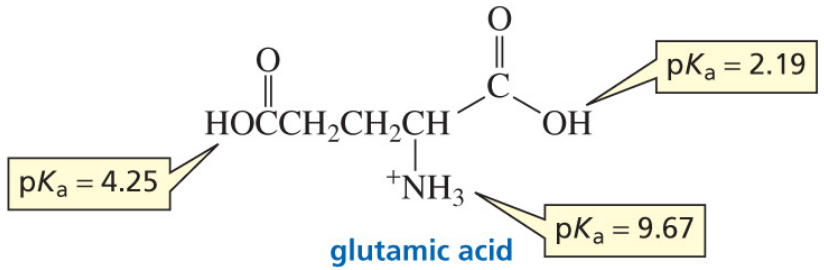
$$pI = \frac{2.34 + 9.69}{2} = \frac{12.03}{2} = 6.02$$

Amino acids: Isoelectric Point (pI)

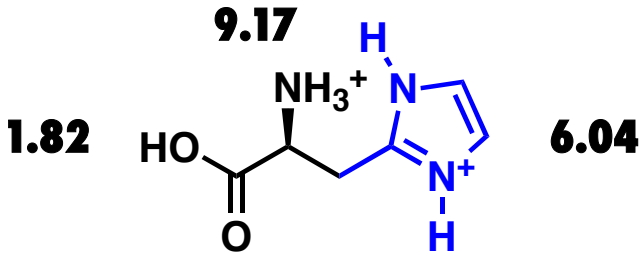
pI of amino acid is pH at which it has no net charge



$$pI = \frac{8.95 + 10.79}{2} = \frac{19.74}{2} = 9.87$$



$$pI = \frac{2.19 + 4.25}{2} = \frac{6.44}{2} = 3.22$$



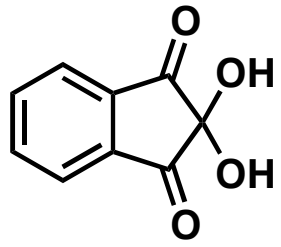
similarly ionizing groups

Amino acids: Separation/Purification

electrophoresis

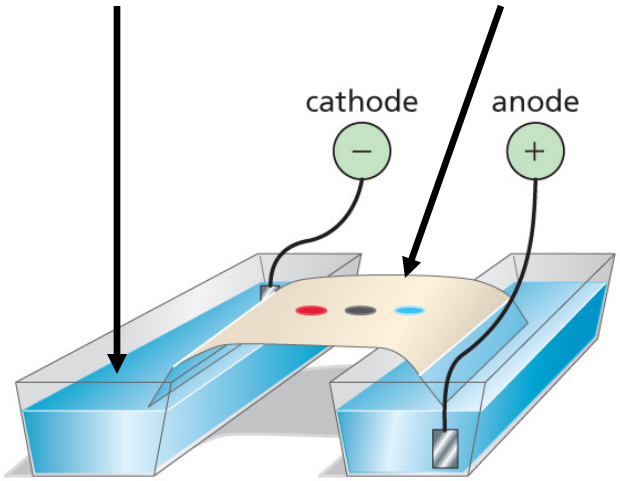
based on pI values of amino acids

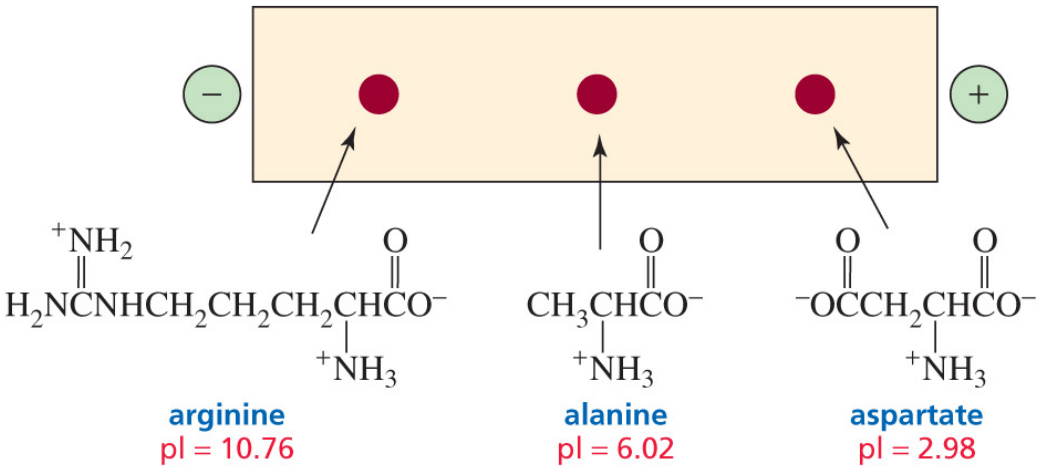
visualized with ninhydrin:



buffer

paper or gel

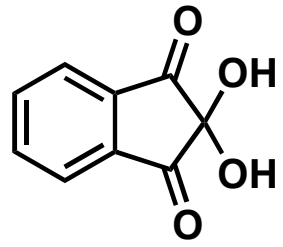


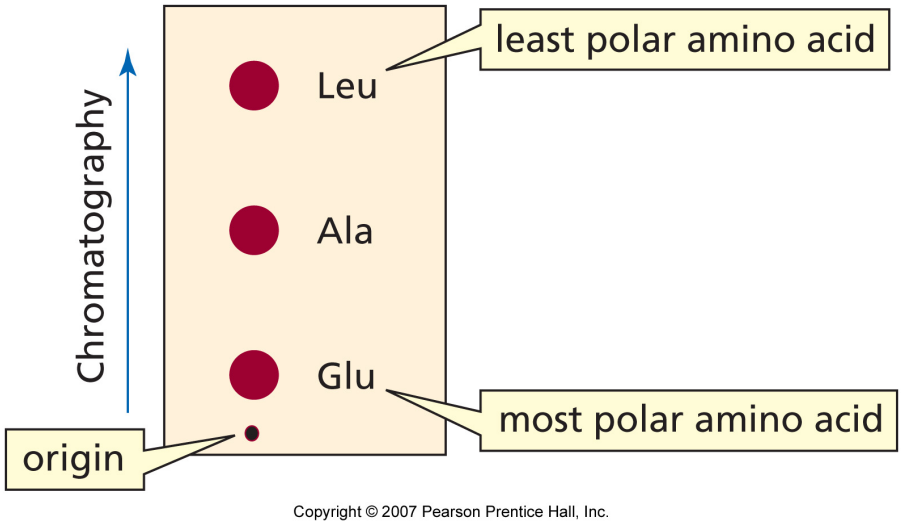


arginine, alanine, and aspartate separated at pH = 5

Amino acids: Separation/Purification

- **paper/thin layer chromatography**
  - **based on polarity**
  - **visualized with ninhydrin:**



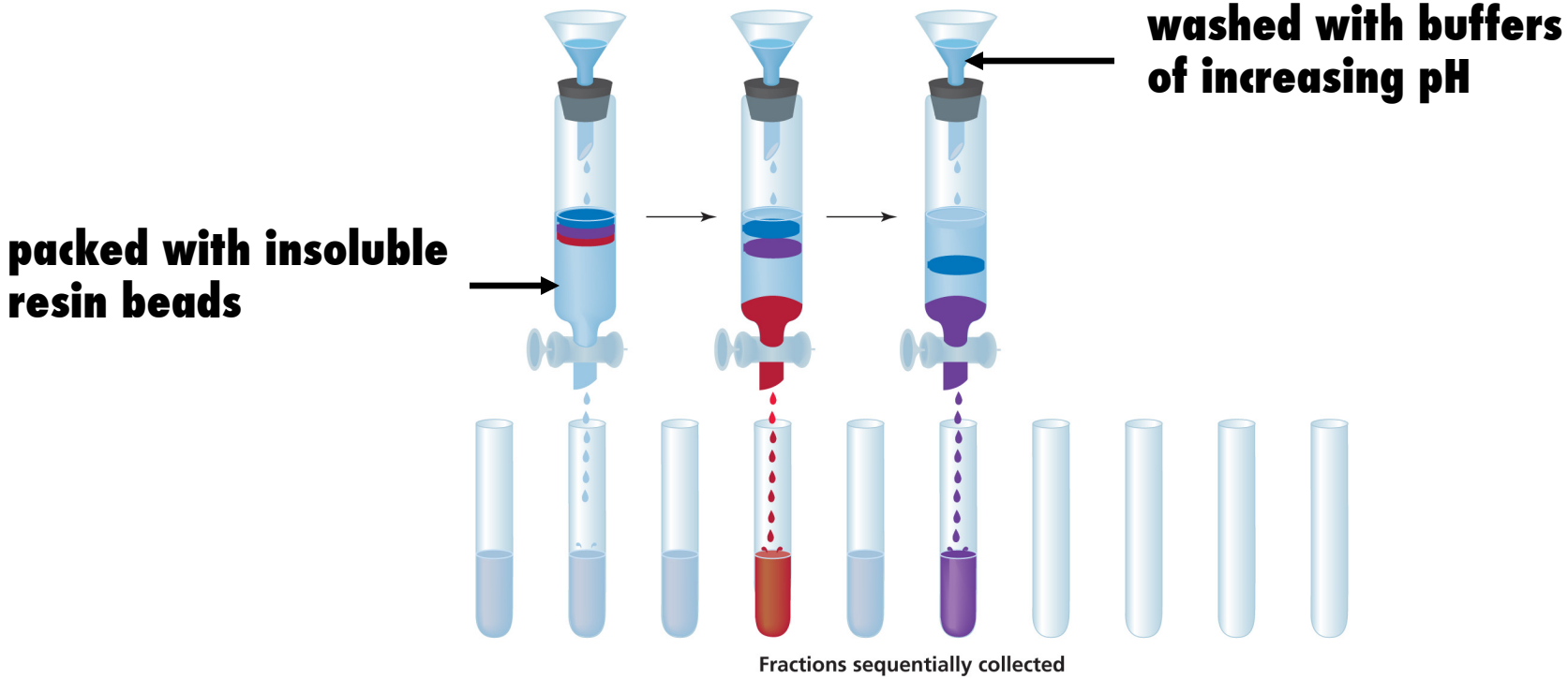


glutamate, alanine, and leucine

Amino acids: Separation/Purification

ion-exchange chromatography

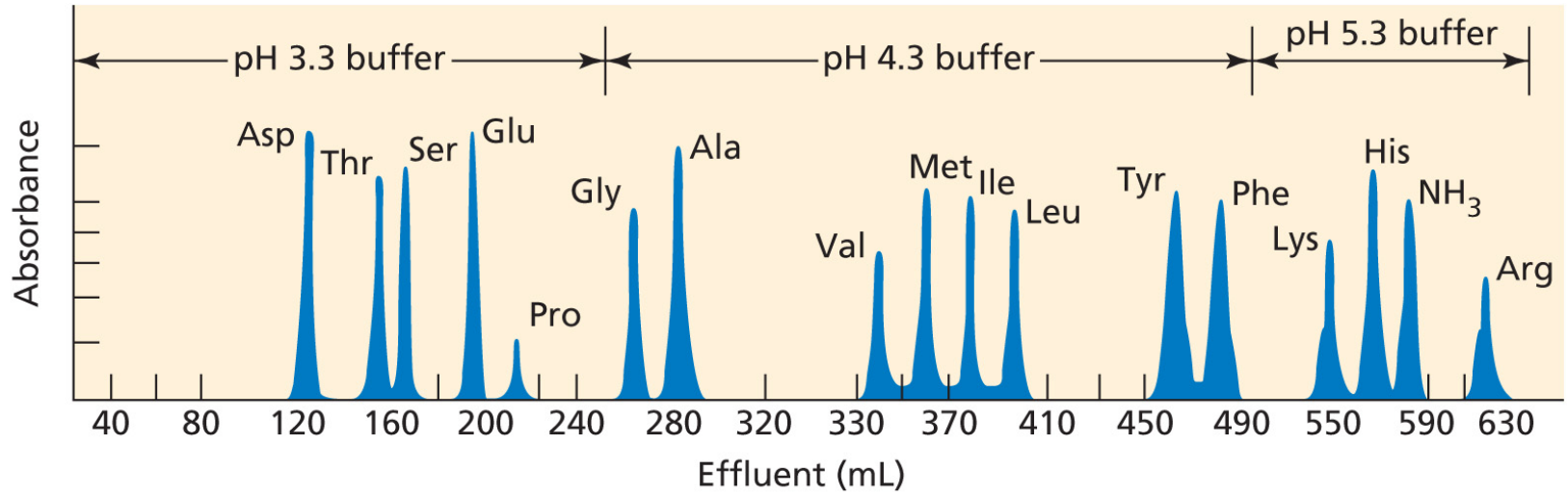
based on ions/charge
used on preparative scale



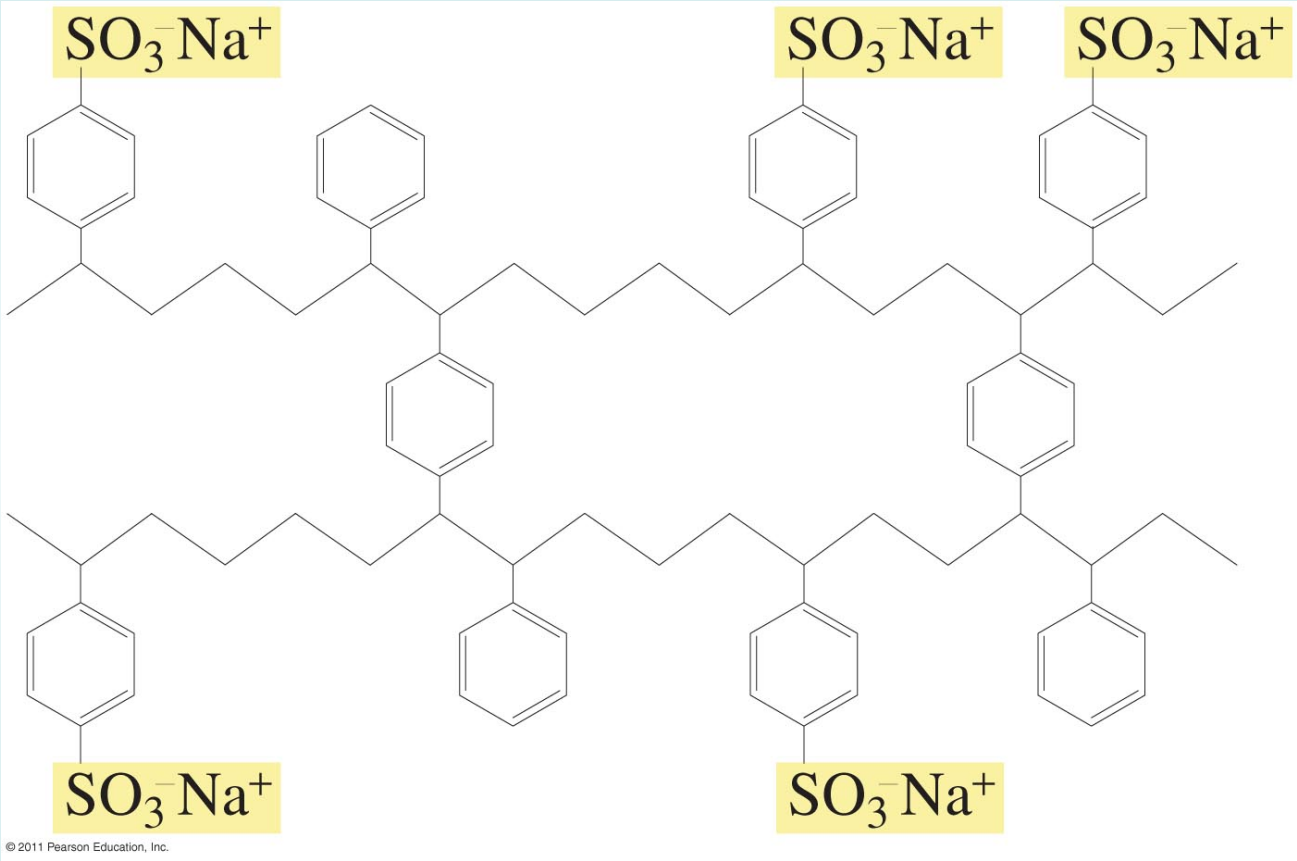
Amino acids: Separation/Purification

ion-exchange chromatography

A typical chromatogram obtained from separation of amino acids using an automated analyzer



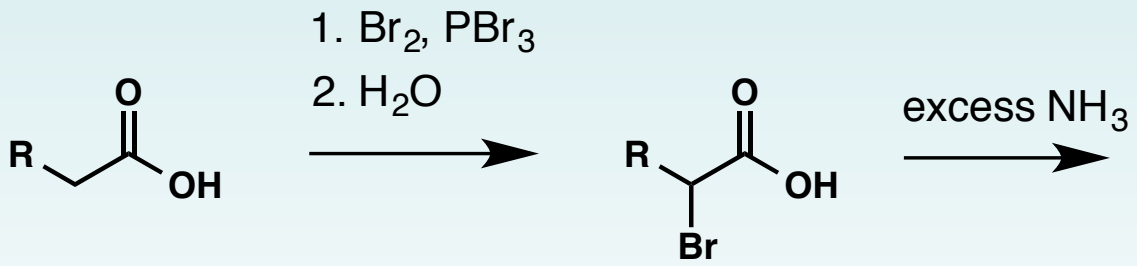
Ion-exchange chromatography can be used to perform preparative separation of amino acids:

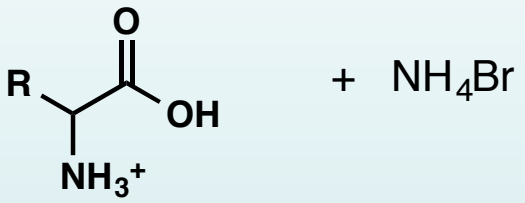


Negatively charged resin binds selectively to positively charged amino acids

Amino acid synthesis: HVZ reaction

Hell-Volhardt-Zelinski reaction, see Section 18.5

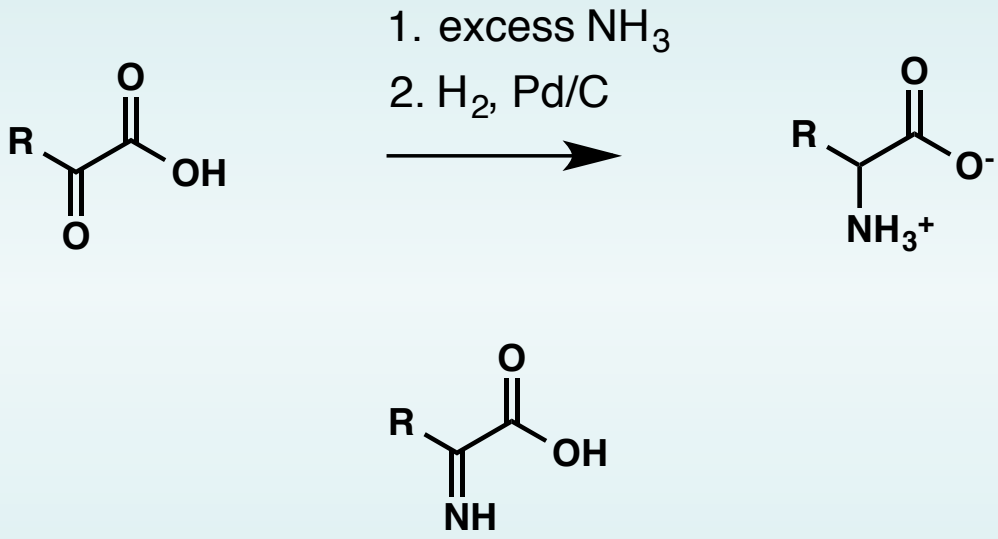




+ NH_4Br

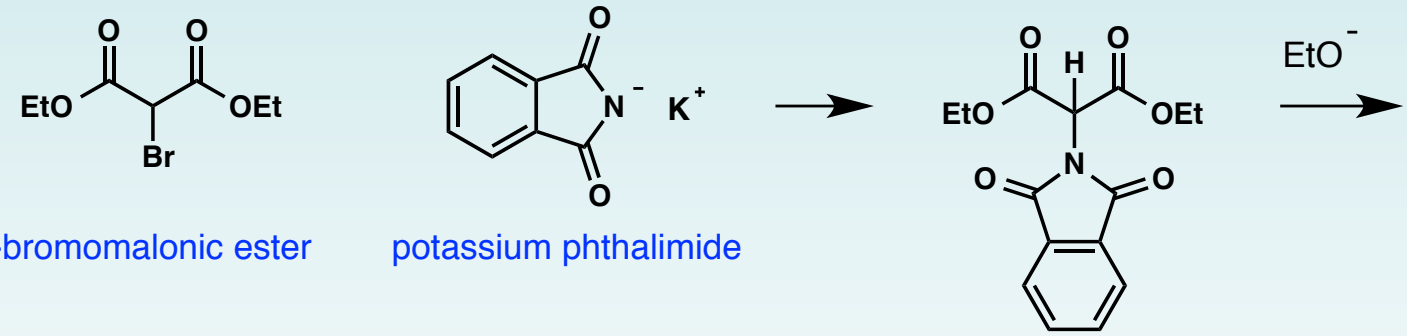
Amino acid synthesis: reductive amination

review Section 17.10



intermediate

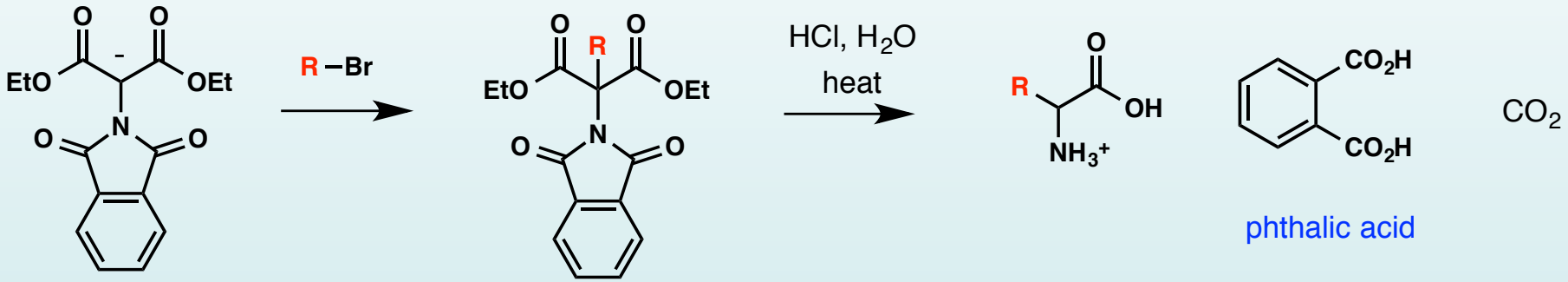
Amino acid synthesis: *N*-phthalimidomalonic



α-bromomalonic ester

potassium phthalimide

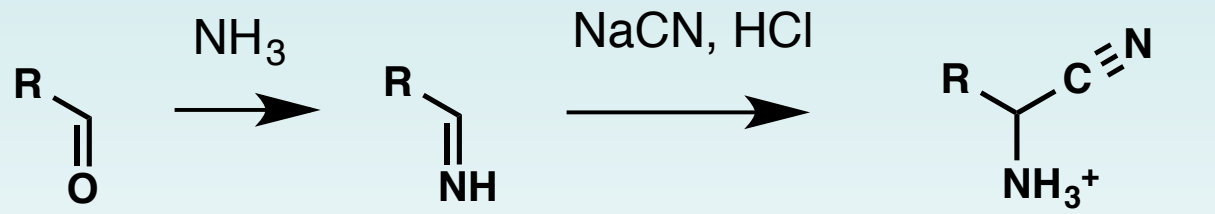
N-phthalimidomalonic ester



phthalic acid

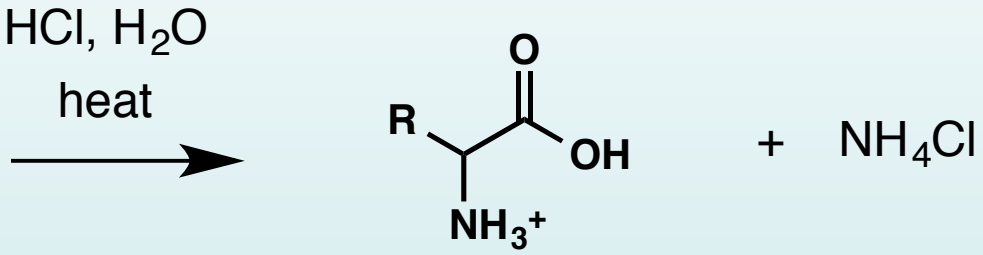
review Sections 18.18, 16.18, and 18.1

Amino acid synthesis: Strecker synthesis



an imine

α-amino nitrile



review Section 16.19 for nitrile hydrolysis